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Is there a crisis in school science education in the UK?

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Abstract

This paper reviews the extent to which contemporary concerns over the recruitment, training and retention of scientists have persisted among science education policy makers. Drawing upon key government reports that have been commissioned in order to review the position of science education and training over the last 90 years, we consider the historical context of contemporary 'moral panics' about the position of science education in schools. Three themes emerge: the nature and purpose of the school science curriculum, the recruitment of science undergraduates, and the teaching of science in schools. The review suggests that many of the concerns which pre-occupy us today, such as the perceived 'quality' of the science teaching workforce, are the very same that existed when science was first introduced as a school subject. This raises issues about the role of policy in influencing educational change more generally but also questions whether there ever was a 'golden age' for science education in the UK.

Introduction

'Grave shortage of science teachers'

'1500 unfilled university places'

'University science places unfilled'

Headlines such as these taken from *The Times* newspaper are not unfamiliar to those involved in training the next generation of scientists, engineers and technologists. We frequently read that science undergraduates are less well qualified in comparison with Arts and Humanities undergraduates; that too few Physics teachers have appropriate qualifications; that falling numbers on degree programmes result in the closure of university Physics and Chemistry departments and so on. But what is perhaps most interesting about these headlines is not that they reflect contemporary concerns about the state of science education but rather that each headline was written over 40 years ago by commentators who appear to be concerned with the very same 'science problems' that preoccupy us today. In this paper, we are interested in the extent to which perspectives on the 'science problem' have changed over time and consequently in asking whether there ever was a 'golden age' for science education in the UK? Drawing upon key Government reports that have been commissioned in order to review the position of science education and training over the last 90 years, we

consider the historical context of contemporary 'moral panics' about school science education.

As we shall see here, the evolution of school science education from its status as a minority subject a century ago to its current position at the core of the National Curriculum in England and Wales has not been straightforward. In the later part of the Nineteenth Century, curriculum debates were focussed largely around the primacy of the Mathematical and Classical curriculum versus the status of 'newer' subjects such as modern languages and science (Turner 1980, Delamont 1988). Curriculum reformists during this period, most notably the British Association for the Advancement of Science (BAAS), sought to establish a science curriculum in the country's schools and thus seek parity of esteem between the Classical and Scientific subjects (Layton 1981). Their efforts, in particular, were directed towards the large public schools which had traditionally been more resistant to the teaching of science. Thus leading to worries among some reformists about the 'unequal diffusion of scientific knowledge' between the different social classes: 'it would be an unwholesome and vicious state of society in which those who are comparatively unblest with fortune's gifts should be generally superior in intellectual attainment to those above them in station' (Lord Wrottesley, cited in Layton 1981, p190). This resistance to the teaching of science in some of the country's most prestigious public schools can largely be explained by the close relationship these schools held with the Universities, particularly Oxford and Cambridge, as well as the Army and Civil Service: the entrance examinations for which required a knowledge of the Classics which left little room for the teaching of Science. For example, between 1906 and 1915, 11% of scholarships awarded by the Oxford Colleges were for Science, compared with 63% for Classics (Jenkins 1979).

These demands for a curriculum for science, and with it debate over the nature of such a curriculum, gathered pace during the time of the Great War. Writing in *The Lancet* in 1918, EH Starling complained about the 'gross deficiencies of our educational system ... it is the absence of sciences and scientific method...which has been responsible for our failures of leadership in the conduct of the war, whether at home or on the Western front' (p365). While at the same time Bell was concerned that science education was not keeping pace with the advances being made in scientific investigation and discovery: 'public education is still dominated by traditional aims and little is being accomplished in inculcating the scientific temper of thought' (Bell, 1915, p634). Concerns about scientific illiteracy were not confined to the country's schools, long standing deficits in the scientific knowledge of the political elite and the higher levels of the Civil Service were also evident, as this excerpt from the 'Neglect of Science' committee's memorandum to The Times newspaper in 1916 shows:

'It is not our intention here to enumerate the catalogue of specific instances in which a want of understanding of 'physical' science' has led the ministry and executive into error. This has been done elsewhere, but as an example of the ignorance which we deplore we may instance the public statement of a member of the Government, unchallenged when made, that his colleagues should be excused for not having prevented the exportation of lard to Germany, since it had only recently been discovered that glycerine (used in the manufacture of explosives) could be obtained from lard. The fact is, on the contrary, that the chemistry of soap-making and the accompanying production

of glycerine is very ancient history' (The Times 2nd February 1916, p10, see also Adlam 1919).

Arguably these concerns over an apparent lack of scientific expertise among the political elite remain relevant to this day. At the start of 2009, only two members of the UK government and shadow cabinet had a scientific background: one a medical doctor and the second a Chemistry graduate.

In 1918, in response to concerns regarding this apparent 'neglect of science', the government commissioned JJ Thomson, then Chair of the Royal Society, to lead a review into the natural sciences in the school curriculum. The concern of the Committee about the status of Science was evident from the opening sentence of their report:

'Not for the first time our educational conscience has been stung by the thought that we are as a nation neglecting science' (Committee to Enquire into the Position of Natural Science in the Educational System of Great Britain, 1918, p1).

Following the Thomson Committee's report there have been a number of influential Government-commissioned reports aimed at understanding and remedying the issue of education and training in the sciences. Indeed, whether it is the early Twentieth Century 'neglect of science', or 'the swing from science' we saw during in the 1960s and 1970s or the 'science problems' that we hear about today, concerns about the purpose of science education, how it is taught, who teaches it and to which types of students, have a very long pedigree indeed (see for example, Sykes 1998).

In undertaking this brief review of key government committee reports which relate to science education and training, three themes emerge: the nature and purpose of the school science curriculum, the recruitment of science undergraduates, and the teaching of science in schools.

The schooling of science

We begin here by considering the aims of school science education and in doing so suggest two potentially conflicting roles for science education: to provide scientific training in preparation for university plus a broader social aim of educating a scientifically literate population.

In 1867 the Taunton Committee was commissioned to oversee a curriculum for science; its recommendations were to set down the blue print for school science education that was to remain for next half century (Layton 1981). The Committee listed five arguments for the teaching of science in school: that it would provide mental training and encourage the development of deductive and reasoning skills; that it would form part of a well-rounded education for all students, even those whose aptitude lay in non-science areas; that a knowledge of science was important for all citizens as well as for society; and finally that learning science was both pleasurable and useful (Jenkins 2007). In practice, however, it was the focus on mental training which prevailed, with even the BAAS advocating that the advancement of science education be 'untrammelled by considerations of utility' (Layton 1981, p197). Much

more recently, the Royal Society's State of the Nation review of 14-19 Science and Mathematics Education (Royal Society 2008) has brought further attention to the dual challenges for science education. The first of which, according to the report, is to provide science and mathematics education that is 'appropriate for students of all levels of attainment in an environment where more students remain in education post-16' and the second to 'give a solid core grounding in science and mathematics to those who will probably not continue studying these subjects post-16' (p17). Thus we have a potential tension between the schooling of scientific method in the pursuit of knowledge and the practical utility of scientific knowledge: a tension which arguably prevails.

According to Hurd (1991, p251), in the 200-year history of school science teaching, courses have been taught and organised as 'mirror images' of the research disciplines found in universities, which required early specialisation in preparation for university courses. The need for such early specialism in the sciences had long been criticised for limiting the opportunities for students to study science in the later years of secondary school because of choices they may have made at the age of 14: 'a key area of conflict is the extent to which science teaching should prepare a technical and scientific elite or should be available to and serve the needs of the majority' (Walford 1985, p158). Such criticisms perhaps point to the divisive nature of school science which, according to Young (1976, p59), produces three types of people: the pure scientists who are interested in the pursuit of the truth and who seek an 'abstracted understanding' of science; the applied scientists whose pragmatic approach leads to the economy for example defining the goals of science; and finally the failures, who are anti-science, anti-technology and see science as 'domination'. These concerns are not new, as far back as 1915 the need for a broader curriculum was made apparent: 'the teaching of science needs a complete reorganisation from bottom to top from the point of view of developing the keenest possible interest in the student for a broader knowledge of scientific discoveries' (Bell 1915, p635).

The issue of a broader secondary science curriculum was also raised by the Thomson Committee who advocated science teaching which drew attention to everyday life and the natural phenomenon of science in which science should be 'kept as closely connected with human interests as possible' (Committee to Enquire into the Position of Natural Science in the Educational System of Great Britain, 1918, paragraph 47). Although requiring some specialism post-16 so that 'the imaginative and logical faculties can be best trained by the intensive study of a few subjects' (paragraph 58), the Committee recommended that 'those specialising in science should continue some literary study, and those specialising in literary subjects should give some time to science work of an appropriate kind' (page 239). They also recommended the development of advanced courses in the natural sciences for those not wishing to specialise at university, such courses could be developed by the teacher but ought to include elements of astronomy, geology, meteorology, physiology and the development of scientific ideas.

Forty years later, the Crowther report into the 15-18 curriculum also concluded that the curriculum of the sixth form 'cannot be drawn up with the needs of only future university students in mind' (Ministry of Education, 1959, paragraph 422). Echoing the Thomson Committee's concerns that science specialists ought to be literate and arts specialists numerate, the report was critical of the congested pre-16 curriculum as

well as of the potential negative impact on future careers of limiting subject choices at 14, particularly in science. They argued that this specialisation is made 'not necessarily because of any educational evidence that this is the right age for boys (sic) to make their choice, but in the belief that if they do not start early, they will not be sufficiently prepared by 18 to meet university requirements' (paragraph 314).

In 2005, concerns over the specialist nature of the curriculum were again apparent in one of the more recently published reports on the issue: 'a balance must be struck in the curriculum between what is suitable for the minority who wish to specialise in science and what might be more valuable for the majority who will not become scientists' (Save British Science 2005, p45). In order to achieve this balance the authors advocate, perhaps unsurprisingly, that science remain compulsory in school but that the curriculum be much broader so as to encourage more humanities and arts students to study science as well as teaching science taught across other curriculum areas, for example in History or Religious Education.

As we have seen, the debate over the purpose of science education in schools continues, with some commentators arguing for alternative models for the science curriculum which consider science achievements as 'benefiting the common good and fostering the welfare of individuals' (Hurd 1991 p251). To some extent there has been a lack of agreement over what this society oriented science curriculum should look like but in general there is some consensus that the 'traditional discipline bound science curriculum with the principle goal of preparing students for the practice of science is outmoded in terms of the ethos of modern science, the nation's economy and citizens' education' (Hurd 1991, p257). Indeed, from the Nuffield Science programmes of the 1960s, to the GCSE double science award at the end of the 1980s, to Curriculum 2000 and the Twenty First Century Science programme there have been continued attempts to improve the school science curriculum which its critics continue to perceive to be unapproachable and unappealing (Roberts 2002, p72).

When science became a core component of the National Curriculum in England and Wales in 1989, the debate over enforced specialisation at 14 and the need for a broader curriculum ought to have been resolved: now all students were to spend a significant proportion (for many around 20%) of their time studying science through to the end of compulsory schooling. However, a new phase of the debate has begun with the Government now promising that by 2014, 90% of state schools will offer single subject science teaching (or *triple* science) and the number studying for separate GCSEs in Chemistry, Physics and Biology will be doubled (Brown 2009). This further broadening of the science curriculum is, of course, in the hope that more young people will be encouraged to study the subject beyond the age of 16, an issue we return to in the next section.

The quality and supply of undergraduate scientists

Our discussion of the aims and purposes of school science education has revealed long standing concerns that a narrow science curriculum and enforced early specialisation has led to science becoming an elite subject largely studied by the more able and which has limited relevance to the ordinary citizen. In this next section, we consider the claim that school science has failed to provide sufficient entrants of high

enough quality to fulfil the needs of Higher Education and as a consequence the country's ability to compete economically.

Between the two Wars the number of science and technology students studying at English Universities and University Colleges had hardly varied (Jenkins 1979). This was to change following the economic and social changes which accompanied the end of the Second World War. In 1963 the Macmillan Government commissioned Lord Robbins to review the medium and long-term expansion of Higher Education and in particular to consider how the sector would cope with the predicted shortfall of university places caused by the large numbers of young people who were born after the War and who would be eligible to enter higher education between 1965 and 1968 (Committee of Higher Education 1968). In addition to recommending the expansion of the Higher Education sector, the Robbins Committee also advocated the introduction of broader courses, especially at A-level, as well as combined degree programmes:

‘We do not believe, for example, that it is in the public interest that a student of natural science or technology is frequently not competent in even one foreign language, a student of economics is often without the desirable complement of mathematics and a student of history or literature may be unaware of the significance of science and the scientific method’ (paragraph 204).

However in actuality, the expansion of the Higher Education system as advocated by Robbins had an arguably less desirable impact on the teaching of the sciences at university. Between 1962 and 1967 the proportion of candidates following the sciences at first year A-level fell from 42% of the cohort to 31%; at the same time, the proportion of candidates admitted to study science and technology at university fell from 46% of the cohort to 41%, leading to fears that if things continued as they were, university science faculties would find themselves ‘increasingly recruiting rather than selecting candidates’ (Council for Scientific Policy, 1968, paragraph 6). Such concerns about an apparent ‘swing from science’ led to another government commissioned review of the sciences in Higher Education. The subsequent report: the *Inquiry into the flow of candidates into Science and Technology in Higher Education* (known as the Dainton report), followed the Robbins Report in also recommending a broad range of sixth form studies as a means of encouraging more able young people to study the sciences at Higher Education so that ‘irreversible decisions for or against science, engineering and technology should be postponed as late as possible’ (paragraph 174). The report went further to advocate a review of university entry requirements and the trial of new science, engineering and technology courses specifically designed to attract ‘able entrants who are not already committed to these fields of study’ (paragraph 193). Indeed, according to the Dainton Report this ‘swing from science’ was a consequence of increased competition from other popular and ‘less rigorous’ (p79) subjects, a desire by students for a broader curriculum which meant they opted for more mixed subjects at A level which made studying the sciences at university more difficult, an unimaginative science curriculum which was out of touch with society and poor science teaching; all of which now necessitated a revision of university entrance requirements to attract candidates from outside the ‘science stream’ (Council for Scientific Policy 1968).

One reason given for the apparent relative decline in the number of students studying science post-16 was the increased choice of mixed arts and science options that were now available to a growing sixth form population, many of whom would additionally have had to have chosen to specialise in the sciences around age 13 (McPherson 1969, Council for Scientific Policy 1968, Duckworth and Entwistle 1974). Two groups in particular were affected by the increase in the number of students staying on post-16: girls and students of lower ability. Neither group according to Duckworth and Entwistle (1974) were likely to study the sciences:

‘The sciences have not really ‘lost’ many recruits because of a change in pupils’ attitudes towards science, rather some have been attracted away by the welcome diversification of sixth form courses while others, ‘new’ sixth formers, have never been serious candidates for science (or languages) courses because they find these subjects particularly difficult’ (p53).

Of course, the same argument could be made for the apparent decline in the share of undergraduate students opting to study the sciences that we see today. In other words, that the relatively recent expansion of Higher Education has attracted students who were not likely to study science anyway. One indication that this might be the case is the lack of variation in the characteristics of undergraduates who have chosen to study the Physical Sciences over the last twenty five years or so: they are still largely high achieving, traditional aged, white, middle class men (Smith 2008).

The consequence of a wider choice of subjects at A-level on the uptake of science at university is interesting. According to Osborne et al. (2003), the percentage of students pursuing science or science and mathematics post 16 has declined by more than one half, a trend which began in the 1980s and is a consequence of greater choice of mixed A level combinations. Indeed the introduction of AS levels as part of the Curriculum 2000 reforms reflected the desire from many quarters for a broadening of the curriculum that extends even beyond the Robbins report. While AS qualifications appear to have been successful in broadening the curriculum experience for students, they have resulted in a decline in the percentage taking the three sciences at A level (Howson and Sprigade 2006). Although the ten most popular three A level combinations are still science based and between them account for 10% of the A level cohort (Bell 2003).

Indeed, the issue of a broader A level curriculum divides opinion between those who feel the country can ‘ill afford’ to produce three times as many arts and humanities specialists as science specialists (Osborne 2003, p1052) and those who criticise science teaching, both in school and at university, for perpetuating a scientific and technical elite: ‘science teaching began and continues with its main purpose to maintain the supply of future scientists’ (Young 1951, p51, see also Walford 1985, Committee of Higher Education 1963, Starling, 1918). Once more this is a criticism that is by no means new: ‘science courses in college seem to be dominated largely by the aim of training for higher specialisation and the tendency is to eliminate more and more of the general student body’ (Bell 1915, p635).

The perceived lack of quality of science undergraduates in comparison to those in other fields has been an issue at least since the 1960s (McVey 1970). For example, the Black Papers which were published towards the end of the decade were particularly

scathing in their assessment of A level candidates: from 1965 onward apart from the very best candidates in mathematics ‘no scientific or technological subject was able to require a standard of performance on the part of its best candidates (those achieving AAA to BCC) to match economics, geography, English, French or history (Pollard 1969, p78). Once at university, science undergraduates were more likely to leave before completing their degree: in 1966 12.8% of Physical Science (excluding mathematics) students did so, compared with 6.3% in the Arts. According to McVey (1970) the ‘rot set in’ during the 1960s with the expansion of the universities and the pure and applied science faculties (p28). The author cites a 1964 article in the *Times Educational Supplement* reporting more than 900 unfilled places in science and technology which no suitably qualified candidate could fill despite ‘undemanding’ entry qualifications.

The poor skills demonstrated by undergraduate students once they had been accepted onto their degree course, is a particularly longstanding issue. Indeed, the 2002 Roberts review into the supply of science professionals suggests that the decline in the numbers of students taking science A-levels may result in a lowering of quality among the undergraduate intake, particularly if the need to fill places results in offers being made to less well qualified applicants (Roberts 2002).

This is a particular issue for mathematics where concerns are often raised about the declining number and quality of students entering this and other numerate disciplines (Smith 2004, Smithers and Robinson 2006). For example, we frequently read about students who are unable to cope with the mathematics content of their courses and who possess insufficient mathematical skill for the study of Physics and Engineering and in cases where there are students who can cope with the mathematics, they fail to apply it (Gill 1999, Smith 2004, UK Mathematics Foundation 2005, Royal Society 2007, Jones 2009). However, many of the issues raised here aren’t particularly new: back in 1971 it was reported that ‘many students of science subjects arrive at university with little faculty and less interest in maths’ (cited in Gill 1999, p83). The reasons for the problem today are perhaps clearer: fewer students now have two mathematics A-levels and some, given the broader curriculum and choice of qualifications now on offer, may have no mathematics A-level at all. In addition, the mathematics A level syllabus and assessment techniques have changed enormously over the last twenty years or so, not so the Undergraduate mathematics syllabus that is taught to physics students, for example: this has ‘scarcely changed in living memory’ (Gill 1999, p86). Even so the recommendations for change are seen mainly to lie with the schools and the need to strengthen mathematics teaching at secondary school as well as the quality of the teachers themselves in order to ensure that there is a marked increase in ‘the number of students taking and enjoying a serious A level in mathematics’ (UK Mathematics Foundation 2005, p1).

Despite the concerns of the authors of the Black Papers, science and mathematics A-levels are still high status subjects which are likely to be taken by the highest attaining students (Selkirk 1972, Walford 1985, Bell 2003 and 2003a, Leslie 2003, Croxford 1997). Indeed, debates about the quality of science undergraduates reveal an interesting paradox: on the one hand the students who study these subjects post 16 are among the most able in their cohort, but on the other ‘the sciences are both objectively harder and widely perceived to be so’ (Coe et al 2008, p136). In an environment where all subjects are treated as equivalent, for example, in league tables and

university entry requirements, there may be incentives for students to take easier subjects which may in turn impact upon recruitment to the sciences (Coe et al 2008). Indeed the elite status of the pure sciences in particular is perhaps one explanation for the apparent post-16 'swing from science' we experienced during the 1960s and which is arguably being replicated in participation in science subjects at HE today. Put simply it is that able students who are interested in the sciences were always likely to choose to study these subjects post-16 and were always potential recruits to Higher Education and were relatively unaffected by more recent widening participation agendas. Where attrition from the sciences among this group may have occurred is to the newer scientific disciplines such as psychology.

Poor teaching

'The teaching of natural science presents a sorry spectacle of inadequacy or misdirected effort all along the line' (Bell 1915, p635).

'By far the most serious problem for science education is the supply of suitably trained teachers, particularly at secondary school' (Save British Science 2005, p53).

According to the Royal Society, 'teachers are the largest single source of variance in learning other than the students themselves' (Royal Society 2006, p3), but, as the above quotations show, concerns over the quality of school science teaching are not new. Back in 1918, the Thomson Committee blamed competition from industry for the shortage of well-qualified teachers and advocated both an increase in salaries and a 'revolution' (paragraph 72) in the public's attitudes towards teachers:

'The first and indispensable condition for any real improvement in the teaching of science in schools of all kinds is that effective steps should be taken to secure an adequate supply of properly qualified teachers. The supply is inadequate for existing needs...' (Committee to Enquire into the Position of Natural Science in the Educational System of Great Britain 1918, paragraph 71).

Following the First World War, restrictions on scientific Research and Development meant that what industrial expansion which did take place was largely in areas which recruited non-graduate scientists. Consequently as the primary career destination for the increasing numbers of science graduates was teaching, a period of 'chronic over-supply' of teachers ensued (Jenkins 1979, p230). In fact it was not until after the Second World War and the subsequent generation of scientists that the Thomson Committee's concerns about industrial competition for teachers were fully realised. Indeed, after World War II rapid industrial expansion and the demand from industry for physics and chemistry graduates, in particular, resulted in the concerns about quality and supply to the profession that persist today (Smithers and Robinson 2005, Moor et al. 2006). By the time of the 1953 Morris report into the supply of teachers, there was a widely acknowledged 'serious inadequacy' in the supply of mathematics and science teachers, what teachers were in post were of poor quality and there were several examples of schools sharing science staff to overcome shortages. The Morris report concluded that shortages were a 'national problem' (paragraph 46) and that the

output of mathematics and science graduates could not supply the needs of the three main competitors: school, industry and the universities. Their concerns are illustrated in Table 1 below:

Table 1: First degree mathematics and pure science students, England and Wales, 1952¹

	Teacher training (%)	Research/PG courses or university teaching (%)	Industry or commerce (%)
Men	20	40	33
Women	50	25	20

The Morris report was followed in 1959 by the Crowther report which again pointed to the scarcity of good sixth form science teaching and of the need to attract both male and female teachers of the highest calibre (Ministry of Education, 1959). Similar concerns were echoed by Robbins in 1963 and by Dainton in 1968 who argued that in 1965 36% of mathematics teachers and 22% of physics teachers were not qualified in the subject they taught and that 27% of maths teachers had no qualifications in any science subject at all (Council for Scientific Policy 1968).

By the 1970s, Physics teaching in particular was viewed as a ‘dying art’ (Young 1976 p48), there were difficulties in recruiting science specialists, particularly females and consequently the country was sort of about 3400 mathematics teachers (Jones 1973). Indeed, in 1977 it was estimated that 38% of all mathematics teaching (or 9000 teachers) in maintained secondary schools was undertaken by teachers whose qualifications were ‘weak’ or nonexistent. By the time of the 1982 Cockcroft report (Committee of Inquiry into the teaching of mathematics in schools, 1982) into the teaching of mathematics (commissioned in response to a lack of suitably qualified maths teachers), a shortage of good mathematics teachers had been a concern for many years, both a consequence of rising birth rate and increased competition for mathematicians from commerce and industry.

More recently the Robert’s review has drawn attention to the ‘consistent failure’ (p. 4) to recruit sufficient numbers of suitably qualified candidates to Initial Teacher Training Programmes, as well as over the levels of initial training that teachers receive and the concern that teachers were teaching in science areas not covered by their degree (Roberts 2002). Similar situations have been reported by Smithers and Robinson (2005), Moor et al. (2006) and Margo et al. (2008).

Alongside such concerns about the supply and quality of the science teaching profession, there has been no shortage of suggested remedies. The Robbins review, for example, advocated alternative undergraduate courses:

‘the great majority of undergraduate students of mathematics have neither the aim nor the ability to become mathematicians of the front rank, and for them somewhat less concentration would be appropriate in order to make way for the study of some other suitable subject such as physics or chemistry’ (Committee on Higher Education 1963, p92).

¹ The remainder of graduates were employed by the government or nationalised industry. These figures account for 2/3 of graduates and exclude those doing national service, who were unemployed or for whom no information was available.

The Dainton Report along with the Roberts Review and the organisation Save British Science have all suggested the use of ‘positive incentives’ (Council for Scientific Policy 1968, paragraph 186) such as increased earnings for classroom science teachers, improved ‘on the job’ training and sabbatical leaves and the development of schemes to encourage doctoral scientists to spend time in schools. By 2002 such incentives included financial incentives aimed at attracting more high quality trainees and sizeable ‘golden hello’ payments for those who successfully complete their induction teaching period in priority subjects. Today a prospective teacher trainee in mathematics or science can expect a £9000 tax free bursary plus golden hello payments of up to £5000.

Despite such incentives, it seems we are in no better a position today with regard to the quality of the science and mathematics teaching workforce than we were in the years prior to the Second World War. For example a recent study into the deployment of mathematics and science teachers reports that one fifth of Physics teachers were subject specialists, compared with 44% of Biology teachers, and also that high attaining schools in more affluent areas were more likely to employ science specialists than schools working in more challenging circumstances (Moor et al. 2006).

Discussion

“This is Britain’s path to the future, lit by the brilliant light of science” (Blair, 2006)

In his speech to the Royal Society in November 2006, then Prime Minister Tony Blair declared himself to be ‘born again’ and ‘fascinated’ by the scientific process. In addition to praising the entrepreneurial skills of British scientists, and the pivotal role of science in our ‘knowledge economy’, his speech evoked a heady mixture of scientific accomplishments: advances in genetic sequencing, stem cell research, nanotechnologies and the science of climate change - which he likened to the ‘moon landing of our day’. In this speech the former Prime Minister described much of what is important, exciting and challenging in the field, even going so far as to describe scientists as ‘stars’ who should be celebrated on a par with our famous actors and sportsmen and women. But Blair also confessed to a prior view of science as being for ‘people who were devoid of emotion, the boffins, the ones who took an extraordinary interest in things I found irritating’. This view of science as being something that ‘other people do’ is not unfamiliar (see for example, the results from PISA 2006, (OECD 2007), Holman 2005) and although it contrasts starkly with Blair’s image of scientists working at the frontier of knowledge, it is nevertheless a view that persists. In the UK, the media is replete with stories of science in crisis: fewer young people are enrolling in the sciences at university (BBC 2007), there are insufficient well-qualified science teachers in schools (Guardian 2008) and the cost to the economy of the ‘swing’ from the sciences is estimated in billions of pounds (The Times 2008).

The response to this ‘crisis account’ surrounding the supply and skills of future Science Technology Engineering and Mathematics (STEM) professionals by the Brown government has been an ambitious 10 year Science and Innovation framework (HMT 2004). The aim of which is:

“for the UK to be a key knowledge hub in the global economy, with a reputation not only for outstanding scientific and technological discovery, but also as a world leader in turning that knowledge into new products and services” (HMT 2004, p5).

The government’s commitment to make ‘Britain the best country in the world in which to be a scientist’ (Brown 2009) is underlined by recession proof increases in the Science Budget to around £11.24 billion (or of about 17.5% between 2007/08 and 2010/11) (House of Commons 2008). The motivations behind such initiatives are largely economic and represent industry’s concerns for a suitably skilled workforce (CBI 2008), particularly in the face of competition from other established and emerging economies, such as India and China (Society of Chemical Industry 2006, Leitch Review of Skills 2006). Central to addressing the ‘skills shortage’ is increasing recruitment to the STEM subjects at school, at university and through vocational and work based provision, a commitment underlined by the Higher Education Funding Council’s new £21 million STEM Centre at the University of Birmingham.

As before, the key to developing the nations’ scientific skills base is once again through increasing recruitment, an expanded network of training provision, a better qualified teacher workforce and a more scientifically literate population. Or as Gordon Brown suggested in a recent speech at Oxford University: ‘while not everyone is in the business of science, science is everybody’s business’ (Brown 2009). But as this paper has attempted to show these preoccupations with the science agenda are not new. Indeed, this brief examination of several key government reports into the position of school science in the UK over the last 90 years has revealed some long established trends. From its very inception as a school subject, concerns have been raised over the nature and purpose of the school science curriculum and its dual objective of training a scientific elite and ensuring that we are a nation of scientifically literate citizens. With this has come tension between the need for a specialist science curriculum at age 14 which allows a smooth transition to further study and the desire for a broader curriculum which has room for a wider treatment of the field of science. Making science a compulsory component of school science in 1989 has arguably shifted this tension to the post-16 curriculum where a broader choice of subjects has, according to some commentators, further diluted specialism and resulted in a decline in both the quality and quantity of university applicants. One possible explanation for why recruitment to the Physical Sciences, in particular, has failed to keep up with the recent expansion of Higher Education more generally is that the new recruits to Higher Education are those who were unlikely to study science anyway. Physical Science students have among the highest entry qualifications of all UK Higher Education students, with some exceptions, most would have continued to university regardless of the programme of recent expansion and so perhaps we should not be surprised that patterns of participation have not kept pace with subjects with arguably less demanding entry requirements. A further concern is, of course, the quality of the teaching profession and problems with the recruitment of teachers with the appropriate skills to teach science, again an issue that has been pertinent for as long as science has been taught in schools.

In summary, a reading of government commissioned reports and other research does seem to suggest that the concerns that preoccupy the STEM agenda today are not particularly new: many of the same concerns that were raised by the Thomson

Committee in 1918 were revisited by Roberts in 2002. All of which really asks, if not now - when more students are studying science at school than ever before, when over 40% of university undergraduates are studying science or science-related disciplines and when one third of Physical Science graduates undertake postgraduate research degrees - then when *was* there a 'golden age' for science education in the UK?

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